Model Organisms: The Genes We Share

Description

Why spend millions of dollars and countless hours studying worms, yeast, fish, and mice? These creatures look and act so differently from us, yet we are more related than you may think. In this unit, students explore the structure and function of DNA, discover our relatedness to other organisms, learn the characteristics of the ideal model organism, and create trading cards that summarize why model organisms are important in scientific research.

Packet Contents

Introduction

This unit is designed for 7th grade science and/or high school biology students. It is meant to be hands on, visual, and fun. In this unit, students learn the structure and function of DNA, extract and compare DNA from multiple organisms, research the significance of a model organism, and create model organism trading cards to share what they have learned, in an engaging way. The primary objective is for students to see how related humans are to other species on Earth in order to realize the global value of studying model organisms.

Curriculum Alignment: *NC Essential Standards, 7th Grade Science & Biology*

7.L.1 Understand the processes, structures and functions of living organisms that enable them to survive, reproduce and carry out the basic functions of life.

7.L.2 Understand the relationship of the mechanisms of cellular reproduction, patterns of inheritance and external factors to potential variation and survival among offspring.

8.L.4.1 Summarize the use of evidence drawn from geology, fossils, and comparative anatomy to form the basis for biological classification systems and the theory of evolution.

Bio.3.1.1 Explain the double-stranded, complementary nature of DNA as related to its function in the cell.

Bio.3.3.1 Interpret how DNA is used for comparison and identification of organisms.

Common Core Standards:

CCSS.ELA-LITERACY.RST.6-8.3: Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks.

CCSS.ELA-LITERACY.RST.6-8.7: Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table).

Objectives

Students Will Know:
-the location, structure, and function of DNA
-the relative amounts of DNA that living things share
-the characteristics of good model organisms
-examples of current model organisms
-why studying model organisms is important

Students Will Be Able to:
-Extract DNA by following a multi-step scientific procedure.
-Construct DNA models by matching base pairs and building genes.
-Persuade others of the benefits of experimenting with model organisms.
-Observe and identify structures/traits of select model organisms.

Time & Location

All lesson activities to be conducted indoors. Length of class period and number of days may vary, so suggested timing is provided below

1. (10 min): Comparative Embryology Activity & Discussion
2. (15 min): The Genes We Share Activity & Discussion
3. (45 min): Concurrent DNA Extraction LABS: 2-3 stations out of 5
4. (15 min): Class DNA Puzzle & Discussion
5. (45 min): DNA Sequence Bracelets & Discussion
6. (10 min): Intro Model Organisms Slideshow
7. (90 min): Model Organism Research & Trading Card Creation

Teacher Materials

1. Comparative Embryology cards printed and coded (7 sets)
2. The Genes We Share cards printed (7 sets)
3. DNA Extraction Lab handouts (10 copies for each station)
    A. Dish soap, isopropyl alcohol, salt, blue food coloring, clear plastic cups, small vials, ziplock bags, coffee filters, coffee stirs, food processor, paper towels.
    B. Strawberries, Bananas, green split peas, yeast packets
4. DNA Puzzles Small (7 sets) pre-cut in ziplock bags
    OR
    DNA Puzzle Large (1 set made with multi colored construction paper)
5. DNA Sequence Bracelets
    A. Handouts (7 copies of instructions, cards, pairing rules, and sequence information documents)
    B. Elastic string (60cm per student)
    C. Red, yellow, green, blue beads (~44 per student)
6. Device and projection technology for Intro to Model Organisms Slides
7. Wheel Graphic Organizer handouts for note-taking (1 per student)
8. Laptops to research model organisms & create digital trading cards (1 per student)
9. Trading Cards Directions & Rubric handouts (1 per student)

Student Materials

Materials provided by teacher. See teacher materials above.

Safety

-No safety equipment needed
-Teacher should remind students not to put lab materials in, or near, mouth and eyes.

Student Prior Knowledge

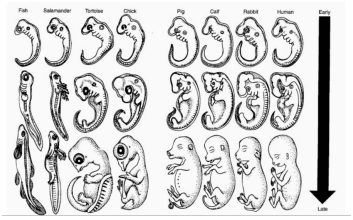
-Characteristics of living things
-The structure and function of organelles within a cell
-Prokaryotic versus Eukaryotic cells
-Unicellular versus multicellular organisms

Teacher Preparations

-Purchase all supplies listed in teacher materials above
-Make copies of handouts listed in teacher materials above
-Pre-cut (and laminate, if able) embryo cards, the Genes We Share cards, and DNA Puzzle pieces. Organize into zip lock bags as desired.
-The day before DNA extraction labs, organize materials for DNA extraction stations, puree green split peas, and purchase fresh fruit.

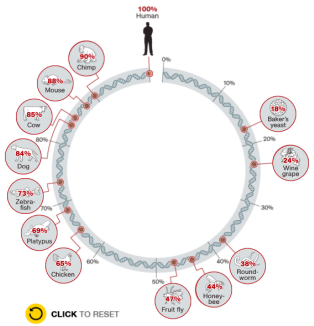
Activities

1. **Comparative Embryology Activity**:
   a. Teacher will pass out sets of embryo cards to groups of 3-4 students.
   b. Teacher will ask students to match each embryo with the correct organism.
   c. Student groups will do their best to arrange embryo cards to match organism.
   d. Teacher will remind students to observe carefully and discuss as a group before making final matches.
   e. Students are not expected to match correctly.
   f. Teacher will reveal answers.



g. Students should be surprised at how similar these animals look in the beginning and wonder why.
h. Allow class to discuss why the embryos look so similar in the beginning and what this could mean.
i. Teacher may guide students to the concept of common ancestry and evolution of organisms using these graphics. Teacher should help students conclude that life on Earth used to be more similar before genetic divergence and speciation. Similar embryonic development is evidence of this. All living things must maintain the characteristics of life, especially at the cellular level, and therefore are more alike than you'd think.

2. **The Genes We Share Activity**:
   a. The teacher will project the blank version of the 0%-100% genetically similar to humans scale on the smart board / screen. (or draw this scale on the board).
   b. The teacher will direct groups of 2-4 students to draw a smaller version of the same scale on paper or whiteboard, 1 per group.
   c. The teacher will give each group 1 student set of the organism pictures.



   d. The students will debate the percent of genetic similarity to humans each organism possesses, and show it visually by placing the pictures on their small scale. Students will also write a percent next to the picture.
   e. The teacher will coordinate the whole class to arrange the larger organism cards on the large scale on the board by how much DNA they think they share with humans. Attach to board with tape (cheering encouraged). Have students consult the class and write the percent of genetic similarity above each organism on the scale.
   f. The teacher will remind students that all living things share the characteristics of life, especially at the cellular level, and therefore, are more alike than one might think.
   g. The teacher will remind students that many processes and proteins are highly conserved across species. Examples for higher level students include the process of replicating DNA, gastrulation (establishing inside versus outside of creature), compacting DNA in an organized way around histones using condensin proteins, splicing proteins that cut DNA, breaking down sugar for energy, etc.
   h. The teacher will reveal the homology/relatedness (See 1st graphic on "The Genes We Share" document.
   i. Give students this Exit Ticket (optional).

j. Gifted Extension: The teacher may show students this graphic of Mouse v Human chromosomes, and ask students to analyze it. What does the graphic show? What does it mean?
k. ESL / LD Students: The teacher may print small sets of the 0%-100% scale and organism percentages to allow small groups of students to arrange for themselves on their table.

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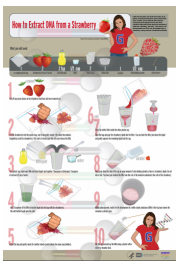
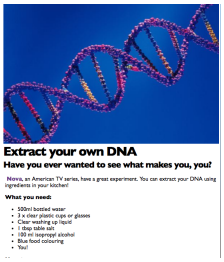
3. Concurrent DNA Extraction Labs:





a. The teacher will orient the students to all DNA extraction stations that have been previously set up (See teacher materials and teacher preparation above).
b. The teacher will show students the copies of lab directions at each station (Use these resources: PreLab Reading for Strawberry DNA Extraction, strawberry DNA extraction worksheet, cheek cell DNA extraction worksheet, strawberry DNA extraction infographic, green split peas, yeast (more: banana, chicken liver, oats).
c. Student pairs will move from station to station following the written procedures, recording results when necessary, and cleaning up behind themselves.
d. Students may record methods, observations, and answers to questions in science journals as teacher desires.
e. The teacher will roam answering questions, refilling materials, probing students for understanding.
f. Optional: The teacher may give each student a small vial and piece of yarn/string to make a DNA necklace. Students may proudly store, display, and discuss the extracted DNA outside of class.
g. The teacher will conduct a whole-class review/reflection at the end of DNA extraction.
    i. Where is the majority of DNA found within a cell? *(nucleus)*
    ii. What do you observe about the DNA extracted from each species? Similar? Different? *(All DNA looks, feels, acts the same way because it is made of the same basic components in all living things)*
    iii. Why is it important for scientists to be able to extract DNA? *(to study the genetic causes of disease, for the development of diagnostics and drugs, for carrying out forensic science, for sequencing genomes, for detecting bacteria and viruses in the environment, and for determining paternity (Source)*
    iv. What types of careers might involve extracting DNA, comparing DNA sequences, or manipulating DNA? *(forensic scientist, molecular biologist, genetic counselor, etc.)*

h. Gifted student may complete all stations and bring in other foods from home to experiment with.
i. ESL / LD students may complete 1-2 stations and be paired with bilingual students or teacher's aid.

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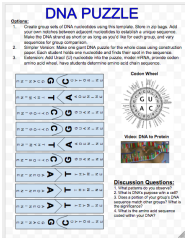
4. **DNA Puzzle**



a. The teacher will pass out puzzle packets to each small group of 3-4 students.
b. The teacher should clarify and remind students that this puzzle represents a much larger version of the white stringy DNA that was extracted yesterday from each organism.
c. The students will work together to solve the puzzle.
d. The teacher will prompt students to analyze any observable patterns in the DNA sequence
e. The students will answer the following discussion questions as a small group on paper and then aloud as a whole class.
    i. What patterns do you observe?
    ii. What is DNA's purpose within a cell?
    iii. Does a portion of your group's DNA sequence match other groups? Why is this significance?
    iv. Gifted: What is the amino acid sequence coded within your DNA?
f. ESL / LD: Make one giant DNA puzzle for the whole class using construction paper. Each student holds one nucleotide and finds their spot in the sequence.
g. Gifted extension: Add Uracil (U) nucleotide into the puzzle, model mRNA, provide codon amino acid wheel, have students determine amino acid chain sequence.

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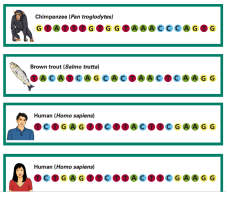
5. **DNA Sequence Bracelets**



a. The teacher will write and read this question on the board and let students know that this will be the exit ticket for the day: Why do we share so many genes with other organisms?
b. The teacher will play a segment of **Cosmos Season 1 Episode 2: time ~14:47 min - 17:25** to serve as a review and to help students answer the daily question.
c. The teacher will set up for DNA sequence bracelets by passing out trays, cups with beads, string, and handouts.

d. The students will follow written and verbal directions to make a DNA sequence bracelet representing an organism and gene of their choice.
e. Students will naturally compare their choices and bracelets to their peers. The teacher should expect and promote genetic conversation during bracelet-making.
f. The teacher will have students answer these questions in an exit ticket:
    i. In which organism is your particular sequence of DNA?
    ii. What does your DNA sequence code for within the organism?
    iii. Why do we share so many genes with other organisms?
    iv. How might sharing genes with other organisms be useful to humans?
g. Address the answers to these questions the next day as a warm up.

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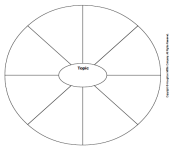
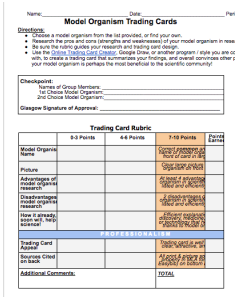
6. **Intro to Model Organisms Slideshow**



a. The teacher will pass out the wheel graphic organizer, KEY.
b. The teacher will advance through the slideshow.
c. The students will record 8 ideal characteristics of ideal model organisms in the wheel graphic organizer.
d. The teacher will have students use the criteria to determine if example organisms are good or bad model organism. (see slides for key)

Assessment

7. **Model Organism Trading Cards (directions & rubric)**

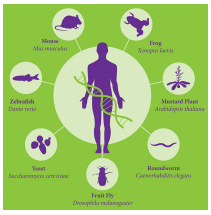

Model Organism Trading Cards

Directions:

Checkpoint:

Trading Card Rubric

a. The teacher will hand out the trading card directions and rubric.
b. The teacher will explain the research project and available resources, and answer any questions the students may have.
c. The students should have their wheel graphic organizer and rubric out as a reference while researching and designing their trading card.
d. The students may work alone or in pairs at the teacher's discretion.
e. The students must get the teacher's signature of approval on desired model organism before starting. Teacher should ensure there is variety. (Ex: Fruit Fly, *C. Elegans* Worm, Frog, Mustard Plant, Yeast, Mouse, Zebrafish)



f. The student teams will research their chosen model organism and summarize the pros and cons of the model organism in the form of a trading card.
g. The students are encouraged to use this Trading Card Template, but may use another platform as desired. Here is a Sample Trading Card.
h. The teacher will make copies of final products after editing and review.

i. The student groups will give a 1-3-minute mini presentation to the class summarizing the info on their trading card, and emphasizing why studying their model organism is important.
j. The students will trade cards to make a complete set.

Critical Vocabulary

Evolution, Adaptation, DNA, Genes, Traits, Proteins, Embryo, Model Organisms, Homology

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